Near Experimental Hall Laser Systems

October 18, 2008

- NEH Laser System
- Laser Optical Transport Design
- Laser Controls and Interface
- Discussion of Laser Parameters for Experiments
NEH Laser System and Optical Transport

Laser Hall

Hutch 1
Hutch 2
Hutch 3

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NEH Laser Systems

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Laser Conceptual Design

5 W Nd:YVO₄

30 fs Ti:sapphire Oscillator 800 nm

Pulse Stretcher
30 fs Bandwidth

Dazzler

20 W Nd:YLF Pump Laser @ 527 nm 1.2 kHz

Regenerative Amplifier
1 kHz, <5 mJ

Pulse Cleaner

Multi-Pass Preamplifier
10-30 Hz, <100 mJ

Optical Transport

Pulse Compressor
(Single Grating)

Harmonics

Topaz OPA

300 mJ Nd:YAG Pump Laser @ 532 nm 10-30 Hz

OR

120 mJ Nd:YAG Pump Laser @ 532 nm, 120 Hz

300 mJ Nd:YAG Pump Laser @ 532 nm 10-30 Hz

120 mJ Nd:YAG Pump Laser @ 532 nm, 120 Hz

300 mJ Nd:YAG Pump Laser @ 532 nm 10-30 Hz
FY09 Laser Purchase

Laser Hall

Pulse Stretcher
30 fs Bandwidth

Regenerative Amplifier
1 kHz, <5 mJ

Pulse Cleaners

Optical Transport

Pulse Compressor (Single Grating)

Harmonics

5 W Nd:YVO₄

30 fs Mode
Locked Ti:sapp @ 800 nm

20 W Nd:YLF Pump
Laser @ 527 nm 1.0 kHz

DIAGNOSTIC SUITE
-Spectrometer
-Autocorrelator
-Frog
-Beam Analyzer
-Power Meters
-Oscilloscopes

Laser Hall

Hutch 1 & 2

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Master Oscillator and RF Synchronization

**Femtolaser Synergy 20**
- 780 nm Operation
- 68 MHz Pulse Rate Frequency
- Pulse width: <20 fs
- Bandwidth: >40 nm FHWM
- >400 mW / 5.3 nJ/pulse

**Femtolock Synchronization**
- <100 fs timing jitter
- Lock to 476 MHz external source (7th harmonic of 68 MHz)
- Remote Control of Hardware
Coherent Legend Elite Amplifier

- Legend Elite Ti:sapphire Amplifier
- Single Amplification Stage
- Integrated Pump Laser
- 780 nm Operation
- 30, 120, or 1000 Hz rep rates
- 3.5 mJ per pulse with pulse cleaner
- Pulsewidth: 35 fs
- Contrast Ratio: $10^6:1$ (1ns after peak)
- Spatial Mode: TEM$_{00}$: $M^2 < 1.35$
- Energy Stability: <0.75%
Optical Schematic of Laser Transport

Stretcher and 1 kHz Regen Amplifier

20fs Ti:sapp Oscillator

Insertable Mirrors

To Hutch 1

To Hutch 3

Imaging Telescope

Laser Hall

VEC

Pol

Pockels cell

Hutch 2

SXR Chamber

Focusing Optics

Diagnostic Mirrors

2\omega VEC

Harmonics

Hutch 2 Table

Pulse Compressor

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Controls Schematic for Laser Transport

\[ \frac{\lambda}{2} - 1 \]

PM1

PM2

C1

C2

PM4

F2

Laser Hall

Hutch 2

Laser Oscillator Controls

Spectrometer

To Experiment

Harmonics

To Experiment

2\omega VEC

PM5

ESD 1.6-115-r0

Hutch 2

L1

L2

L3

M1

M2

M3

M4

L4

L5
EPICS Interface for Laser Controls

Please do NOT touch this screen unless you know what you are doing!!

Transport Tube

M18  M17  M16  C1  C2  C-IrisVCC  Laser WP  PM2  PM3  LEAVE CLOSED  XCOR Shutter Close Open

M6  M5  M4  M3  LF  L6  LC1  LC2  M2  M1  Fdbk Loop2

To The Cathode

25.083 uJ

Laser Power

VCC

VCC-WP

C1  C2  C-IrisVCC

Rst  Rst  Rst

Iris Web Cam

Cross Correlator

Oscillator Control

Tek Vid

Teking

Alignment Laser

PRODUCTION

laser_in20_main.ed

01/30/2008 14:27:07
EPICS Controls for Laser Positioning and Feedback Loops

CCD Frame Grabber Display

Motion Controls for Motors/Feedback Loops

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Questions for Discussion

- What are your laser wavelength requirements beyond $\omega$, $2\omega$, and $3\omega$?
- What pulse widths are required?
  - transform limited pulse
  - chirped pulse
- What focused spot sizes do you require?
  - FEL beams sizes at the interaction region
    - 10 $\mu$m FEL $\rightarrow$ ~100 $\mu$m laser focus
    - 1 mm FEL $\rightarrow$ ~1 mm laser focus
Questions for Discussion Continued

- Collinear vs. Non-collinear beam geometry
  - Absolute collinearity for ~100 $\mu$m focused spot sizes
  - Near collinear ($\sim 10^{-2}$ rad) for 1 mm focused beam sizes
- What are your wave-front requirements?

Please contact me if you have questions or optical design requirements.

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Summary

Laser System Parameters
- 780 nm <3 mJ
- 780, 390, and 260 nm wavelengths
- 30-1000 Hz repetition rates

- Laser installation begins 1/09
- AMO experiments with NEH laser begin 5/09
- First LCLS science in 7/09
- SXR experiments with NEH laser begin 1/10